

# NASA TECH BRIEF

## Marshall Space Flight Center



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### Improvements of Zeydel Method for Calculating Flutter of Flat Panels

A report has been published which discusses Zeydel's exact method for calculating flutter boundaries and estimating stresses in an infinite spanwise array of panels. The theory is based on the exact linearized inviscid aerodynamic theory. A general analysis of orthotropic panels is presented that accounts for different edge conditions, elastic foundation, membrane stresses, and viscous and structural damping. Various results are presented for very long panels. Two limits of the exact theory are discussed that correspond to the simple static aerodynamic theory approximation and the traveling-wave theory, respectively. A further result for the mode shape of a semi-infinite panel is presented that shows how a traveling wave is amplified and reflected by the trailing edge.

Extensive numerical calculations are presented for the special case of pinned edge panels, isotropic panel material, zero viscous damping, and no elastic foundation. Comparisons are made with previous results that verify the computational procedure. Design flutter boundaries of mass ratio versus length-to-width ratio are presented for different materials and altitude. Typical mode shapes are also given. The effect of structural damping at different Mach numbers and length-to-width

ratios is discussed. Example calculations of the stress level in a panel are made.

Design flutter boundaries are presented for aluminum panels on a typical Saturn V trajectory. Flutter is indicated for certain panels on the forward skirt of the S-IVB stage, that is in agreement with in-flight data. Because of the relatively short duration of flutter, it is concluded that failure is not likely to occur.

#### Note:

Requests for further information may be directed to:  
Technology Utilization Officer  
Marshall Space Flight Center  
Code A&TS-TU  
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